BACTERIOLOGICAL REVIEWS

FOUNDED IN 1937

Published for the SOCIETY OF AMERICAN BACTERIOLOGISTS

VOLUME 24

March, 1960

NUMBER 1

Editor

HENRY W. SCHERP

National Institute of Dental Research Bethesda 14, Maryland

Associate Editors

JACK J. R. CAMPBELL University of British Columbia Vancouver, B.C., Canada

> ERWIN NETER Children's Hospital Buffalo, New York

STANLEY F. CARSON
Oak Ridge National Laboratory
Oak Ridge, Tennessee

JOHN H. SILLIKER Swift and Company Chicago, Illinois

Guest Editors for This Number

COLIN M. MACLEOD

LEIGHTON E. CLUFF

UNIVERSITY OF PENNSYLVANIA

THE JOHNS HOPKINS UNIVERSITY

Copies of this Number may be purchased from the Society of American Bacteriologists, 19875 Mack Avenue, Detroit 36, Michigan. Price \$2.00 in the United States, \$2.25 elsewhere, remittance with order.

THE 1959 FORT DETRICK SYMPOSIUM ON

NONSPECIFIC RESISTANCE TO INFECTION

Held at Hood College, Frederick, Maryland 16 and 17 September 1959

Sponsored by the
U.S. ARMY CHEMICAL CORPS, FORT DETRICK
Conducted under the auspices of the
AMERICAN INSTITUTE OF BIOLOGICAL SCIENCES

BACTERIOLOGICAL REVIEWS

Manuscripts should be sent to Henry W. Scherp, National Institute of Dental Research, Bethesda 14, Md.

One hundred reprints, without covers, of articles will be furnished gratis to contributors when ordered in advance. A table showing cost of additional reprints, with an order slip, is sent with proof.

Correspondence concerning business matters should be addressed to The Williams & Wilkins Company, 428 East Preston St., Baltimore, U.S.A.

Bacteriological Reviews is issued quarterly in March, June, September, and December. The four numbers published in one calendar year constitute a volume.

The subscription price is \$4.00 per volume. Add \$.25 per volume additional postage for Canada and \$.75 for all other countries. Members of the Society of American Bacteriologists receive the *Reviews* as part of their dues.

Claims for copies lost in the mails must be received within 30 days (domestic).

Change of address—Publisher must be notified 60 days in advance. Journals undeliverable because of incorrect address will, be destroyed. Duplicates can be obtained (if available) from the publisher at the regular price of single issues.

Subscriptions should be renewed promptly—To avoid a break in your series, subscriptions should be renewed promptly. The publishers cannot guarantee to supply back issues on belated renewals.



THE WILLIAMS & WILKINS COMPANY

Publishers of Scientific Books and Periodicals
BALTIMORE, U. S. A.

SUSTAINING MEMBERS

Society of American Bacteriologists

| ABBOTT LABORATORIES North Chicago, Ill. |
|---|
| ACME METAL PRODUCTS, INC |
| ALBIMI LABORATORIES New York, N. Y. |
| A. S. Alor CoSt. Louis, MoLos Angeles, Calif. |
| American Agar and Chemical Co San Diego, Calif. |
| American Can. Co |
| AMERICAN CYANAMID Co. (Agric. Div.) Princeton, N. J. |
| AMERICAN INSTRUMENT Co., INC Silver Spring, Md. |
| AMERICAN OPTICAL CO Buffalo, N. Y. |
| AMERICAN SCIENTIFIC LABORATORIES, INC Madison, Wisc. |
| American Sterilizer Erie, Pa. |
| Anchor Serum CoSt. Joseph, Mo. |
| Anheuser-Busch, Inc St. Louis, Mo. |
| Armour Laboratories |
| AYERST LABORATORIES New York, N. Y. |
| BALTIMORE BIOLOGICAL LABORATORYBaltimore, Md. |
| BAUSCH AND LOMB OPTICAL CORochester, N. Y. |
| BECTON, DICKINSON AND CORutherford, N. J. |
| Bello Glass Co |
| BORDEN FOODS CO |
| Bramhall, Deane Co |
| Brinemann Instrument Inc Great Neck, L. I., N. Y. |
| Bristol Laboratories, Inc |
| BUCKMAN LABORATORIES, INC |
| BURGESS PUBLISHING CoMinneapolis, Minn. |
| BURROUGHS, WELLCOME AND CO New York, N. Y. |
| CARWORTH FARMS, INC New York, Rockland County, N. Y. |
| CASE LABORATORIES |
| CASE DABURATURIES |
| Corr many Johnson Engagerovas Burnary Type Now York N. V. |
| CHILEAN IODINE EDUCATIONAL BUREAU, Inc., New York, N. Y. |
| CIBA PHARMACEUTICAL PRODUCTS, INCSummit, N. J. |
| CIBA PHARMACEUTICAL PRODUCTS, INCSummit, N. J. COCA COLA CO |
| CIBA PHARMACEUTICAL PRODUCTS, INC |
| CIBA PHARMACEUTICAL PRODUCTS, INCSummit, N. J. COCA COLA COAtlanta, Ga. COLORADO SERUM CODenver, Colo. COMMERCIAL SOLVENTS CORPTerre Haute, Ind. |
| CIBA PHARMACEUTICAL PRODUCTS, INC |
| CIBA PHARMACEUTICAL PRODUCTS, INC. Summit, N. J. COCA COLA CO. Atlanta, Ga. COLORADO SERUM CO. Denver, Colo. COMMERCIAL SOLVENTS CORP. Terre Haute, Ind. CONSOLIDATED LABORATORIES, INC. Chicago, Ill. CORNING GLASS WORKS. Corning, N. Y. |
| CIBA PHARMACEUTICAL PRODUCTS, INC. Summit, N. J. COCA COLA CO. Atlanta, Ga. COLORADO SERUM CO. Denver, Colo. COMMERCIAL SOLVENTS CORP. Tetre Haute, Ind. CONSOLIDATED LABORATORIES, INC. Chicago, Ill. CORNING GLASS WORKS. Corning, N. Y. CORN STATES LABORATORIES. Omaha, Neb. |
| CIBA PHARMACEUTICAL PRODUCTS, INC. Summit, N. J. COCA COLA CO. Atlanta, Ga. COLORADO SERUM CO. Denver, Colo. COMMERCIAL SOLVENTS CORP. Terre Haute, Ind. CONSOLIDATED LABORATORIES, INC. Chicago, Ill. CORNING GLASS WORKS. Corning, N. Y. CORN STATES LABORATORIES. Omaha, Neb. COULTER ELECTRONICS, INC. Chicago, Ill. |
| CIBA PHARMACEUTICAL PRODUCTS, INC. Summit, N. J. COCA COLA CO. Atlanta, Ga. COLORADO SERUM CO. Denver, Colo. COMMERCIAL SOLVENTS CORP. Terre Haute, Ind. CONSOLIDATED LABORATORIES, INC. Chicago, Ill. CORNING GLASS WORKS. Corning, N. Y. CORN STATES LABORATORIES. Omaha, Neb. COULTER ELECTRONICS, INC. Chicago, Ill. CUTTER LABORATORIES. Berkeley, Calif. |
| CIBA PHARMACEUTICAL PRODUCTS, INC. Summit, N. J. COCA COLA CO. Atlanta, Ga. COLORADO SERUM CO. Denver, Colo. COMMERCIAL SOLVENTS CORP. Terre Haute, Ind. CONSOLIDATED LABORATORIES, INC. Chicago, Ill. CORNING GLASS WORKS. Corning, N. Y. CORN STATES LABORATORIES. Omaha, Neb. COULTER ELECTRONICS, INC. Chicago, Ill. CUTTER LABORATORIES. Berkeley, Calif. DIFFO LABORATORIES, INC. Detroit, Mich. |
| CIBA PHARMACEUTICAL PRODUCTS, INC. Summit, N. J. COCA COLA CO. Atlanta, Ga. COLORADO SERUM CO. Denver, Colo. COMMERCIAL SOLVENTS CORP. TETRE HAUTE, INd. CONSOLIDATED LABORATORIES, INC. Chicago, Ill. CORNING GLASS WORES. Corning, N. Y. CORN STATES LABORATORIES. Omaha, Neb. COULTER ELECTRONICS, INC. Chicago, Ill. CUTTER LABORATORIES. Berkeley, Calif. DIFCO LABORATORIES, INC. Detroit, Mich. DIVERSEY CORP. Chicago, Ill. |
| CIBA PHARMACEUTICAL PRODUCTS, INC. Summit, N. J. COCA COLA CO. Atlanta, Ga. COLORADO SERUM CO. Denver, Colo. COMMERCIAL SOLVENTS CORF. Tetre Haute, Ind. CONSOLIDATED LABORATORIES, INC. Chicago, Ill. CORNING GLASS WORES. COrning, N. Y. CORN STATES LABORATORIES. Omaha, Neb. COULTER ELECTRONICS, INC. Chicago, Ill. CUTTER LABORATORIES. Berkeley, Calif. DIFCO LABORATORIES, INC. Detroit, Mich. DIVERSET CORP. Chicago, Ill. DOW CHEMICAL CO. Midland, Mich. |
| CIBA PHARMACEUTICAL PRODUCTS, INC. Summit, N. J. COCA COLA CO. Atlanta, Ga. COLORADO SERUM CO. Denver, Colo. COMMERCIAL SOLVENTS CORP. TETRE HAUTE, INC. CONSOLIDATED LABORATORIES, INC. Chicago, Ill. CORNING GLASS WORKS. COrning, N. Y. CORN STATES LABORATORIES. Omaha, Neb. COULTER ELECTRONICS, INC. Chicago, Ill. CUTTER LABORATORIES. Berkeley, Calif. DIFCO LABORATORIES, INC. Detroit, Mich. DIVERSEY CORP. Chicago, Ill. DOW CHEMICAL CO. Midland, Mich. EBERBACH CORP. Ann Arbor, Mich. |
| CIBA PHARMACEUTICAL PRODUCTS, INC. Summit, N. J. COCA COLA CO. Atlanta, Ga. COLORADO SERUM CO. Denver, Colo. COMMERCIAL SOLVENTS CORP. Terre Haute, Ind. CONSOLIDATED LABORATORIES, INC. Chicago, Ill. COENING GLASS WORKS. Corning, N. Y. CORN STATES LABORATORIES. Omaha, Neb. COULTER ELECTRONICS, INC. Chicago, Ill. CUTTER LABORATORIES. Berkeley, Calif. DIFCO LABORATORIES, INC. Detroit, Mich. DIVERSET CORP. Chicago, Ill. DOW CHEMICAL CO. Midland, Mich. EBERBACH CORP. Ann Arbor, Mich. E, I. DUPONT DE NEMOURS & CO., INC. Wilmington, Del. |
| CIBA PHARMACEUTICAL PRODUCTS, INC. Summit, N. J. COCA COLA CO. Atlanta, Ga. COLORADO SERUM CO. Denver, Colo. COMMERCIAL SOLVENTS CORP. Terre Haute, Ind. CONSOLIDATED LABORATORIES, INC. Chicago, Ill. CORNING GLASS WORKS. Corning, N. Y. CORN STATES LABORATORIES. Omaha, Neb. COULTER ELECTRONICS, INC. Chicago, Ill. CUTTER LABORATORIES. Berkeley, Calif. DIFCO LABORATORIES, INC. Detroit, Mich. DIVERSEY CORP. Chicago, Ill. DOW CHEMICAL CO. Midland, Mich. EBERBACH CORP. Ann Arbor, Mich. EBERBACH CORP. Ann Arbor, Mich. EJ I. DUPONT DE NEMOURS & CO., INC. Wilmington, Del. FALCON PLASTIC PRODUCTS. Culver City, Calif. |
| CIBA PHARMACEUTICAL PRODUCTS, INC |

| KEWAUNEE MANUFACTURING Co Adrian, Mich. |
|---|
| KIMBLE GLASS DIVISION, OWENS-ILLINOIS GLASS Co. |
| Toledo, Ohio |
| LABLINE, INC |
| LEDERLE LABORATORIES Pearl River, N. Y. |
| E. Leitz, Inc |
| ELI LILLY AND COIndianapolis, Ind. |
| LOURDES INSTRUMENT CORPBrooklyn, N. Y. |
| MERCK SHARP AND DOHME RESEARCH LABORATORIES |
| Rahway, N. J. |
| MILES LABORATORY Elkhart, Ind. |
| MILLIPORE FILTER CORP Watertown, Mass. |
| NATIONAL DAIRY RESEARCH LABORATORIES INC. |
| Oakdale, L. I., N. Y. |
| NEW BRUNSWICK SCIENTIFIC Co New Brunswick, N. J. |
| NITRAGIN Co., Inc |
| NORWICH PHARMACAL Co., RESEARCH LABORATORIES |
| Norwich, N. Y. |
| ORTHO RESEARCH FOUNDATION Raritan, N. J. |
| PARKE, DAVIS AND CO Detroit, Mich. |
| CHAS. PFIZER AND Co., INC New York, N. Y. |
| PITMAN-MOORE Co., DIV. of ALLIED LABORATORIES, INC. |
| Indianapolis, Ind. |
| PHILIP MORRIS, INC Richmond, Va. |
| PROCTER & GAMBLE CO |
| PROFESSIONAL TAPE Co., INC Riverside, Ill. |
| RED STAR YEAST AND PRODUCTS COMilwaukee, Wisc. |
| SCHERING CORPBloomfield, N. J. |
| CARL SCHLEICHER & SCHUELL CO Keene, N. H. |
| JOSEPH SCHLITZ BREWING CO Milwaukee, Wisc. |
| SCHWARZ LABORATORIES, INC Mount Vernon, N. Y. |
| SCIENTIFIC GLASS APPARATUS Co., INC Bloomfield, N. J. |
| SCIENTIFIC PRODUCTSEvanston, Ill. |
| JOSEPH E. SEAGRAM AND SONS, INCLouisville, Ky. |
| G. D. SEARLE & COMPANY |
| Selas Corporation of AmericaPhiladelphia, Pa. |
| SHARP AND DOHME, INCPhiladelphia, Pa. |
| SHERMAN LABORATORIES Detroit, Mich. |
| SMITH, KLINE & FRENCH LABORATORIES Philadelphia, Pa. |
| Ivan SorvallNorwalk, Conn. |
| SQUIBB INSTITUTE FOR MEDICAL RESEARCH |
| New Brunswick, N. J. |
| STANDARD SCIENTIFIC SUPPLY CORP New York, N. Y. |
| SWIFT & COMPANY |
| TAKAMINE LABORATORY, INC |
| ARTHUR H. THOMAS CoPhiladelphia, Ps. |
| THE UPJOHN CO |
| VICO PRODUCTS CO |
| Wallerstein Co., Inc |
| WILLIAM R. WARNER AND CO New York, N. Y. |
| WILL CORP |
| WILMOT CASTLE CO |
| WINTHROP LABORATORIES, INC |
| WISCONSIN ALUMNI RESEARCH FOUNDATION Madison, Wisc. |
| TIBEOMET TERRET TERRETARE POUNDATION MEGISON, WISC. |
| |

FOREWORD

The United States Army Chemical Corps, Fort Detrick, has been privileged to sponsor the symposium, Nonspecific Resistance to Infection, and this publication of its proceedings. The program was developed by the conference chairman, Dr. Colin M. MacLeod (University of Pennsylvania) in cooperation with Dr. Ivan L. Bennett, Jr. (Johns Hopkins), Dr. Leighton E. Cluff (Johns Hopkins), Dr. René J. Dubos (Rockefeller Institute) and Dr. Harold N. Glassman (Fort Detrick). The latter also was responsible for the administrative arrangements. The meetings were held in the facilities of Hood College, generously made available by President Andrew G.

Truxal. All interested in the host-parasite relationship will be grateful to these individuals, the session chairmen, and the speakers at the symposium whose authoritative views are reflected in this volume.

The 1959 Fort Detrick Symposium represents the first international scientific meeting and monograph sponsored by our laboratories. It is the intention of Fort Detrick to sponsor additional symposia in the future as appropriate occasions arise.

> Riley D. Housewright Scientific Director, Fort Detrick

Note to Contributors

Bacteriological Reviews is published under the auspices of the Society of American Bacteriologists to provide authoritative, critical surveys on the current status of subjects and problems in the diverse fields of microbiology. This includes the occasional short monograph.

Suggestions for timely reviews are solicited; prospective authors are invited to discuss with the Editor the suitability of their proposed manuscripts. The submittal of a synopsis or topical outline for an advisory opinion is recommended. Except for References the editorial style of Bacteriological Reviews is essentially the same as that of the Journal of Bacteriology; contributors should consult the Instructions to Authors published in each issue of the Journal for details. If the preliminary discussions result in a prospective review, the Editor will furnish a manual that summarizes style requirements and specific directions for preparation of manuscripts for Bacteriological Reviews. Each contributor should have this before preparing the final copy for submission. The following suggestions may serve as a general guide.

Plan and Content of Review. A rational, balanced development of the topic, rather than a chronological treatment, is to be preferred. Old history, if any, may be covered usually by simple reference to earlier reviews. A mere compilation or annotated bibliography does not adequately serve the objectives of this journal. The extensive presentation of new experimental material belongs properly in the domain of the monograph or of the appropriate "experimental" journal. Judicious selection of references is an important function of the reviewer. Each citation should be checked with the original publication to avoid embarrassing errors.

Length. The length of a paper is no measure of its quality, and it is only the latter that determines acceptability for publication. However, practical considerations make it desirable to set a provisional limit of 15 to 25 printed pages for a review; text, tables, figures and references included. (About 650-700 words per page; 28 references per page.) A short monograph must come within the size of a single issue, about 70 pages.

The acceptability of a review cannot, of course, be finally decided until the finished product has been examined. Acceptance of a short monograph is also contingent upon the advice of the Editor of the *Journal of Bacteriology*.

Correspondence relating to editorial matters should be addressed to the Editor:

HENRY W. SCHERP National Institute of Dental Research Bethesda 14, Md.